THE CLAIMS

What is Claimed is:

1. An apparatus for sequentially separating components of milk, comprising:

   (a) a milk source;

   (b) one or more cross-flow filtration modules communicatively connected to said milk source, for generating one or more filtration fractions;

   (c) one or more fluid delivery means connected to each of said cross-flow filtration modules to effectuate flow of milk through said cross-flow filtration modules for separation of milk components; and

   (d) one or more means downstream of each of said cross-flow filtration modules for sequentially capturing one or more filtration fractions generated by the cross-flow filtration modules.

2. An apparatus according to claim 1, wherein each cross-flow filtration module comprises at least one permeate, at least one inlet, at least one outlet, and multiple fluid-flow sub-channels that are of equal length between the inlet and the outlet.

3. An apparatus according to claim 1, wherein the one or more cross-flow filtration modules comprise a filtration membrane selected from the group consisting of cellulose-based membranes, polymer-based membranes, and ceramic-based membranes.

4. An apparatus according to claim 1, further comprising a cream separator upstream of said cross-flow filtration modules for removing at least a portion of fatty component from the milk.

5. An apparatus according to claim 1, further comprising a pasteurizer upstream and/or downstream of said one or more cross-flow filtration modules for pasteurizing the milk.

6. An apparatus according to claim 1, further comprising temperature controlling/monitoring means for controlling and monitoring temperature of said milk and/or filtration fractions generated by the one or more cross-flow filtration modules.

7. An apparatus according to claim 1, comprising a cross-flow filtration module for separating the milk from the milk source into a casein-rich fraction and a casein-depleted fraction.

8. An apparatus according to claim 7, wherein the cross-flow filtration module comprises membranes selected from the group consisting of cellulose-based membranes, polymer-based membranes, and ceramic-based membranes.

9. An apparatus according to claim 7, wherein the cross-flow filtration module comprises a membrane having an average pore size in a range of from about 100KD to about 3000KD.

10. An apparatus according to claim 7, wherein the cross-flow filtration module comprises a membrane having an average pore size in a range of from about 100KD to about

1000KD, selected from the group consisting of cellulose-based membranes selected from the group consisting of cellulose membranes, cellulose acetate membranes, and regenerated cellulose membranes.

11. An apparatus according to claim 7, wherein the cross-flow filtration module comprises a polymeric membrane having an average pore size between 800KD and 2500KD and/or a measured bubble point between 65 and 120 PSIG.

12. An apparatus according to claim 7, wherein the cross-flow filtration module comprises a regenerated cellulose membrane having an average pore size of about 100KD.

13. An apparatus according to claim 1, comprising:

an optional first cross-flow filtration module downstream of the milk source and communicatively connected thereto for filtering out all or at least a portion of bacteria contained in the milk;

a second cross-flow filtration module, downstream of the first cross-flow filtration module if provided and communicatively connected thereto, or if not provided, then communicatively connected directly to the milk source, which separates the milk into a casein-rich fraction and a casein-depleted fraction;

means connected to said second cross-flow filtration module for capturing the casein-rich fraction;

a third cross-flow filtration module downstream of the second cross-flow filtration module and communicatively connected thereto, which receives the casein-depleted fraction and further separates it into a fraction that is enriched with albumin and immunoglobulins and a fraction that is depleted of albumin and immunoglobulins;

means connected to said third cross-flow filtration module for capturing the fraction that is enriched with albumin and immunoglobulins;

a fourth cross-flow filtration module downstream of the third cross-flow filtration module and communicatively connected thereto, which receives the fraction that is depleted of albumin and immunoglobulins and further separates it into a β-lactoglobulin-rich fraction and a β-lactoglobulin-depleted fraction;

means connected to said fourth cross-flow filtration module for capturing the β-lactoglobulin-rich fraction;

a fifth cross-flow filtration module downstream of the fourth cross-flow filtration module and communicatively connected thereto, which receives the β-lactoglobulin-depleted fraction and further separates it into a α-lactalbumin-rich fraction and a α-lactalbumin-depleted fraction;

means connected to said fifth cross-flow filtration module for capturing the α-lactalbumin-rich fraction;

a sixth cross-flow filtration module downstream of the fifth cross-flow filtration module and communicatively connected thereto, which receives the α-lactalbumin-depleted

fraction and further separates it into a complex carbohydrates rich fraction and a complex carbohydrates depleted fraction;

means connected to said sixth cross-flow filtration module for capturing the complex carbohydrates rich fraction;

a seventh cross-flow filtration module downstream of the sixth cross-flow filtration module and communicatively connected thereto, which receives the complex carbohydrates depleted fraction and further separates it into a lactose-rich fraction and a lactose-depleted fraction; and

means connected to said seventh cross-flow filtration module for capturing the lactose-rich fraction;

means for discharging and/or recycling the lactose-depleted fraction.

14. An apparatus according to claim 1, comprising:

a first cross-flow filtration module downstream of the milk source and communicatively connected thereto, which separates the milk into a casein-rich fraction and a casein-depleted fraction;

means connected to said first cross-flow filtration module for capturing the casein-rich fraction;

a second cross-flow filtration module downstream of the first cross-flow filtration module and communicatively connected thereto, which receives the casein-depleted fraction and further separates it into a fraction that is enriched with albumin and immunoglobulins and a fraction that is depleted of albumin and immunoglobulins;

means connected to said second cross-flow filtration module for capturing the fraction that is enriched with albumin and immunoglobulins;

a third cross-flow filtration module downstream of the second cross-flow filtration module and communicatively connected thereto, which receives the fraction that is depleted of albumin and immunoglobulins and further separates it into a β-lactoglobulin-rich fraction and a β-lactoglobulin-depleted fraction;

means connected to said third cross-flow filtration module for capturing the β-lactoglobulin-rich fraction;

a fourth cross-flow filtration module downstream of the third cross-flow filtration module and communicatively connected thereto, which receives the β-lactoglobulin-depleted fraction and further separates it into a α-lactalbumin-rich fraction and a α-lactalbumin-depleted fraction;

means connected to said fourth cross-flow filtration module for capturing the α-lactalbumin-rich fraction;

a fifth cross-flow filtration module downstream of the fourth cross-flow filtration module and communicatively connected thereto, which receives the α-lactalbumin-depleted

fraction and further separates it into a complex carbohydrates rich fraction and a complex carbohydrates depleted fraction;

means connected to said fifth cross-flow filtration module for capturing the complex carbohydrates rich fraction;

a sixth cross-flow filtration module downstream of the fifth cross-flow filtration module and communicatively connected thereto, which receives the complex carbohydrates depleted fraction and further separates it into a lactose-rich fraction and a lactose-depleted fraction; and

means connected to said sixth cross-flow filtration module for capturing the lactose-rich fraction;

means for discharging and/or recycling the lactose-depleted fraction.

15. An apparatus according to claim 13, further comprising a pasteurizer upstream and/or downstream of any of the cross-flow filtration modules for pasteurizing the milk source or any one or more filtration fractions generated by the cross-flow filtration modules.

16. An apparatus according to claim 14, further comprising a pasteurizer upstream and/or downstream of any of the cross-flow filtration modules for pasteurizing the milk source or any one or more filtration fractions generated by the cross-flow filtration modules.

17. An apparatus according to claim 13, comprising multiple fluid delivery means arranged in a manner that each cross-flow filtration module is connected to at least one fluid

delivery means, said fluid delivery means function to effectuate a flow of the milk or a fraction of the milk through each cross-flow filtration module.

18. An apparatus according to claim 14, comprising multiple fluid delivery means arranged in a manner that each cross-flow filtration module is connected to at least one fluid delivery means, said fluid delivery means function to effectuate a flow of the milk or a fraction of the milk through each cross-flow filtration module.

19. An apparatus according to claim 16, further comprising temperature controlling/monitoring means for controlling and monitoring temperature of said milk and/or filtration fractions generated by the cross-flow filtration modules.

20. An apparatus according to claim 17, further comprising temperature controlling/monitoring means for controlling and monitoring temperature of said milk and/or filtration fractions generated by the cross-flow filtration modules.

21. An apparatus according to claim 16, further comprising a cream separator upstream of said cross-flow filtration modules for removing all or at least a portion of fatty component from the milk.

22. An apparatus according to claim 17, further comprising a cream separator upstream of said cross-flow filtration modules for removing all or at least a portion of fatty component from the milk.